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3 THE EFFECT OF CONTAINERS ON THE STORAGE OF FLORIDA ORANGES AT TERMINAL MARKETS, 1952

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New York, New York

THE EFFECT OF CONTAINERS ON THE STORAGE OF FLORIDA ORANGES AT TERMINAL MARKETS. [1]

This report deals with the 1952 commercial storage experiments with Valencia oranges from Central Florida stored at Newark, New Jersey, and Providence, Rhode Island. The tests were a part of the investigation on the storage of citrus fruits conducted by the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Refrigeration Research Foundation.

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INTRODUCTION

In recent years the fiberboard carton of half-box size (4/5 bushel) has come into use as a citrus container. In California this type of container has already come into common use for lemons, and in Florida about 3 percent of the total orange shipments are now made in these containers.

Since each year a portion of the orange crop is placed in cold storage for later marketing it seemed desirable to study the performance of the carton during transit and as a storage container. In 4 of the 5 cars of Valencia oranges reported on herein direct comparison between fiberboard cartons and Bruce boxes is afforded.

Diphenyl, which has been used for some years impregnated in the paper of box liners for the control of decay in Florida oranges, has also been used in treating the inside of fiberboard cartons. The odor of this material is objectionable and more desirable treatments have been sought. Recently (see H. T. & S. Office Report No. 266, 1951) tests have shown that Dowicide A plus hexamine is very successful as a dip in the control of decay on oranges, especially when the fruit had been previously washed in a Borax solution and/or packed in a container (or liner) treated with diphenyl. Further information was desired on the value of the new dip without a diphenyl supplement, especially for the purpose of eliminating the liner in Bruce boxes. The fifth car in this report affords comparison between oranges treated with Dowicide A-hexamine packed in Bruce boxes, with and without diphenyl treated paper liners.

SUMMARY

The average transit temperatures in five test carloads of Florida Valencia oranges treated with Dowicide A-hexamine and packed in diphenyl treated half-box size fiberboard cartons and diphenyl treated paper lined and unlined Bruce boxes did not drop below 50° F. between Florida and storage plants at Newark, N. J. and Providence, R. I., yet decay was well controlled during the following sixteen weeks in storage. In general, however, the fruit temperatures in containers at the floors and walls were somewhat colder, but these of course constitute a small proportion of each load.

Oranges in half-box size diphenyl treated fiberboard cartons shipped to Providence averaged slightly higher transit temperatures and developed slightly more skin breakdown in storage than similar fruit packed in diphenyl treated paper lined Bruce boxes in the same cars. Oranges in unlined Bruce boxes shipped to Newark kept lower transit temperatures but developed much more skin breakdown in storage than similar fruit packed in diphenyl treated paper lined Bruce boxes in the same car.

The half-box size fiberboard carton used as a transit container for Florida oranges proved to be a good storage container when stored five high at Providence, R. I., but was not a success in storage at Newark, N. J. where it was stored eleven high. At the latter storage plant the cartons in the lower layers bulged, some needing repair at the market terminal, and the fruit developed severe skin breakdown.

Flavor tests of juice extracted at various inspections showed no correlation of flavor with any other factor. The juice was good in most tests and fairly good even when the oranges had been held for one week at 70° F. after removal from 16 weeks of storage.

The fruit from four of the five cars stored 11 to 15 weeks sold between July 30 and August 26 at a profit for storing. The solid car of oranges in fiberboard cartons stacked 11 high in storage sold at a loss and considerably below the day's market price because of excessive skin breakdown and some damaged containers.

MATERIALS AND METHODS

The fruit of the five cars was stored during the month of May, 1952, and sold from July 30 to August 26, after 11 to 15 weeks of storage. The oranges in cars 1 and 5 were grown in one grove on sour orange rootstock; the oranges of cars 2, 3, and 4 were grown in another grove on grapefruit rootstock. Both groves were located in Central Florida and all fruit were of the Valencia variety, U. S. No. 1 grade.

The fruit in all five cars were dipped two to three minutes in a solution of 2 percent Dowicide A, 1 percent hexamine, and 0.05 percent Ravndal liquid soap. They were then waxed with "Flavorseal," polished, graded and packed naked. All five cars were thus treated, packed and loaded at the same packinghouse.

The containers used in these tests were studied from a storage standpoint by their effect on transit temperatures, storage decay, storage skin breakdown, flavor, profit and loss in storing, and on the value of the carton as a storage container, primarily from the standpoint of handling and stacking. The cartons were diphenyl treated and not ventilated, covers stapled shut, and all were half-box size (4/5 bushel) with inside dimensions of 19 1/4 x 12 1/4 x 8 inches deep. The Bruce boxes were standard 1 3/5 bushel size, and lined with diphenyl treated paper except as noted in car 5.

Cars 1 and 2 contained cartons in one end and lined Bruce boxes in the other end (one-half carload of each) and were stored at Providence. Car 3 consisted of a solid load of cartons; car 4, lined Bruce boxes; and car 5 mixed (lined and unlined) Bruce boxes. These were stored at Newark. The lined and unlined Bruce boxes in car 5 were loaded in separate ends of the car. In the three cars containing cartons, all of the cartons were stacked 7 high, 6 wide, chimney style, three chimneys across the car. In the four cars containing Bruce boxes all boxes were stored in the usual manner, lengthwise, 7 wide, 5 high, layers offset crosswise of the car except in cars 1 and 2 where the boxes in the doorway were stacked crosswise of the car.

Three to six self-recording Ryan thermometers were placed in packages at various positions in each load, as shown in Table 3.

All cars were initially iced at Sanford, Florida, and the bunkers were full at the time of loading. All were fan cars, with the fans sealed in the "on" position during transit. Cars 1 and 5 were shipped with instructions to "re-ice at Potomac Yards;" cars 2, 3 and 4 were shipped under standard refrigeration.

Inspections were made of the fruit; and fruit temperatures were taken manually in various parts of the loads at the time of unloading into storage. Twelve test packages from each of the five cars were set aside in the storage room to be removed and inspected at the New York laboratory after 12 and 16 weeks of storage. In addition, six test packages were set aside from each of the two Providence cars for similar inspections after 8 weeks of storage. No additional packages were set aside at Newark as the 8 weeks of storage inspections there were to be made in the storage room. The test packages from the three mixed cars 1, 2, and 5 were sizes 150, 176, and 200, whereas in the solid carloads (cars 3 and 4) sizes 126, 150, 176, 200, 216, and 250 were used.

All carlots were handled in the usual commercial manner, except that at Providence the Bruce Boxes were stored 3 high, and the cartons 5 high on pallets, 1 pallet deep on the floor. At Newark the pallets were 2 deep, the lower holding 4 layers of boxes or 7 layers of cartons, the upper holding 3 layers of boxes or 4 layers of cartons, respectively.

The temperature of the storage room at Providence ranged from 29 to 33° F., with an average of 31.2°; the relative humidity ranged from 85 to 88 percent, averaging 86.6 percent. At Newark the temperature ranged from 30.5 to 38° F., averaging 32.8°, while the relative humidity ranged from 86 to 90 percent, averaging 88.1.

Test packages set aside in storage at the time of unloading were removed as scheduled and brought to the New York laboratory where they were inspected for commercially important skin breakdown and decay. They were then placed in a storage room at 70° F. (Relative Humidity 70-90 percent), with inspections made after 3 and 7 days of holding. Decay (but not skin breakdown) affected oranges were discarded at each inspection. Taste tests were made of the juice at various inspections.

DISCUSSION OF RESULTS

The Effect of Containers on Transit Temperature.

The following fruit temperatures (Table 1) were obtained with hand thermometers in Car 1 at unloading and are characteristic of temperatures of fruit in similar containers in the same positions in other test cars in this and previous years. This car contained cartons in one end of the car and lined Bruce boxes in the other.

Table 1. Comparative fruit temperatures in cartons and lined boxes in Car 1 at unloading time.

	At wall		Centerline	
Layer	Cartons	Boxes	Cartons	Boxes
	° F.	° F.	° F.	° F.
DOORWAY AREA				
Top	50.0	48.5	52.0	48.0
Middle	51.5	48.0	57.0	50.0
Bottom	46.5	44.5	45.0	47.0
QUARTERLENGTH				
Top	51.0	47.0	51.0	49.5
Middle	53.0	47.0	58.5	52.5
Bottom	49.0	42.0	49.5	44.5
BUNKER				
Top	50.5	47.5	52.0	48.0
Middle	51.0	45.5	49.0	48.0
Bottom	41.0	39.0	43.0	40.0

Comparison of transit and unloading temperatures of companion cars numbers 3 and 4 containing solid loads of cartons and lined boxes respectively is not made here because at loading time the average fruit temperature in the cartons was 5 degrees and the average air (Ryan thermometer) temperature 11.3 degrees lower than that of the lined boxes.

The following fruit temperatures were taken during the unloading of car 5, which contained Bruce boxes only, paper-lined in one end of the car, and unlined in the other (Table 2).

Table 2. Comparative fruit temperatures in lined and unlined Bruce boxes in Car 5 at unloading time.

	At wall		Centerline	
Layer	Unlined	Lined	Unlined	Lined
	° F.	° F.	° F.	° F.
DOORWAY AREA				
Top	51	53	53	56
Middle	48	51	50	55
Bottom	43	47	42	47
QUARTERLENGTH				
Top	53	55	54	59
Middle	50	54	50	61
Bottom	42	46	43	46

Table 3 shows the average fruit temperatures in the different containers during transit of all five test cars. These three tables show that cartons do not cool as rapidly as do lined Bruce boxes, and that unlined Bruce boxes cool more rapidly and to a lower degree than paper-lined boxes. The middle and top layer temperatures did not go below 50° in transit in any instance (Table 3). These temperatures may be satisfactory for this short period of transit, providing the fruit is to be marketed immediately on arrival at the market, but when the cars are to be held at the terminal yards before marketing re-icing may be necessary. When the fruit is to be placed in cold storage the growth of disease organisms might be initiated at the higher transit temperatures to the extent that decay might develop in storage; however such did not occur in these tests. Precooling at the shipping point is about the only method of assuring low transit temperatures throughout the load. The spread between the top and bottom temperatures of these fan cars was much less than is ordinarily found in non-fan cars.

The Effect of Containers on Decay

Total decay (Table 4) was so well controlled in the test packages that the results are of little importance in so far as correlations are concerned. Less than 1 percent developed in any carlot after 8 or 12 weeks of storage and only one car showed more than 1 percent after 16 weeks of storage. This was car 2 where the decay was less than 2 percent. During the holding periods the average decay found at removal about doubled during 3 days at 70° F. and increased nearly tenfold after 1 week. Decay was somewhat equally divided between blue mold and stem end rot, with Alternaria rot developing at the buttons after long storage, especially during the holding period. Although more decay generally developed in cartons than in lined boxes, the difference was not significant. In most instances fruit in unlined boxes developed more decay than fruit in lined boxes. In the unlined boxes of fruit decay followed the heavy skin breakdown.

The Effect of Containers on Skin Breakdown

Only commercially important skin breakdown consisting of severe aging and moderate to severe pitting was scored. This usually increased rather uniformly and to large proportions in most of the tests (see Table 5). The results are not explanatory, as the breakdown is not correlated with any other factor or factors. Storage conditions did not seem to cause the breakdown. Two of the four lots at Newark had the least, while the other two lots had the most skin breakdown of the five cars. Nor did the grove or rootstock affect the amount of breakdown. The fruit of both groves stored at Newark produced maximum and minimum percentages of aging and pitting. There seems to be no explanation why the fruit in lined Bruce boxes in cars 1 and 5, picked and packed the same day from the same grove, developed almost no pitting at Newark but rather heavy pitting at Providence. The transit temperatures of the two cars differed but little. The solid car of cartons (car 3) held the lowest average transit temperatures of all cars but developed the most skin breakdown in storage. Cartons produced more skin breakdown than lined Bruce boxes in nearly all comparisons (cars 1 to 4). In car 5 unlined Bruce boxes had much more skin breakdown than lined Bruce boxes. Pitting and aging usually averaged about the same. Both conditions were heaviest on the smaller sized oranges, which in turn brought lower prices.

The Effect of Containers on Flavor

Flavor tests made of the juice of oranges from the various types of containers at each removal and after holding for 3 and 7 days showed no serious off flavors at any time. The flavor became slightly aged during the holding period after 16 weeks of storage. There was no correlation of flavor with the different types of containers, groves, or rootstocks.

The Effect of Containers on Profit and Loss from Storage

The cost of two carton containers of half-box size is approximately the same as the cost of a Bruce box.

The cost of handling and storing a box of oranges is approximately 35¢ the first month plus 15¢ each additional month, and for half-boxes 21¢ the first month, plus 9¢ each additional month. There is no additional freight charge.

Car 1 - stored May 8 at Providence, on which date 9,585 Bruce boxes averaged $3.27 at New York. During the same week 92 cars averaged $3.30 at New York, and 6 cars averaged $3.56 at Boston. This car was sold at Providence August 23, after 15 weeks of storage, the diphenyl treated paper-lined Bruce boxes averaging $6.40 and the diphenyl treated half-box size fiberboard cartons $3.22(equivalent to $6.44 per box). This is a profit for storing of more than two dollars per box or two cartons.

Car 2 - stored May 26 at Providence, on which date 18,825 Bruce boxes averaged $4.31 in New York. During the same week 101 cars averaged $4.10 in New York, and 3 cars averaged $4.04 in Boston. The car sold at Boston August 26 after nearly 13 weeks of storage, the diphenyl treated paper-lined Bruce boxes averaging $5.35 and the diphenyl treated fiberboard cartons $2.49 (equivalent to $4.98 per box). The average profit for storing was about 66¢ per Bruce box and 16¢ for two cartons.

Car 3 - stored May 19 at Newark, on which date 12,915 Bruce boxes averaged $4.01 in New York City. During the same week 78 cars sold, averaging $4.22. This car, containing diphenyl treated cartons only, sold August 6 at auction in New York City after 11 weeks of storage at an average of $1.79 per carton (equivalent to $3.58 per box). It was the only car of cartons sold that day. On the same market 6,995 Bruce boxes averaged $5.11. The loss in storing this car was about 60¢ per carton (equivalent to $1.20 per box).

Car 4 - stored May 19 at Newark - as was car 3. It contained diphenyl treated paper-lined Bruce boxes only, selling August 18, after 13 weeks of storage, at an average of $5.02 per box on the New York market. On the same day 8,610 Bruce boxes averaged $5.44. The profit for storing this car was 36¢ per box.

Car 5 - stored May 7 at Newark, on which date 8,780 Bruce boxes averaged $3.32 on the New York auction market. During the same week 92 cars on the same market averaged $3.30. The car sold July 30 after 12 weeks of storage at an average of $4.77 per box. The car contained Bruce boxes only, diphenyl treated paper-lined boxes averaging $4.94 as against $4.60 for unlined boxes. The average profit for storing this car was 80¢ per box (97¢ for lined and 63¢ for unlined).

The Effect of Storage on Fiberboard Cartons (half-box size).

The two extra handlings required in storing and removing from storage plus 11 weeks of storage, stacked 11 high, apparently were the main causes of repair being necessary to some cartons at the auction market of Car 3. Moisture condensation inside and outside of the carton after removal from storage helped weaken the containers. The lower layers of this lot showed bulging shortly after entering storage. Although the damage at the market was not too serious it might have had some effect on the low price. Skin breakdown, particularly aging, no doubt had the major effect, especially on the small sizes. Stacking of cartons in storage has already become a problem to storage houses, a factor that will probably be solved by double or triple decked pallets. Carton construction should be such that the container would not be weakened by high humidity in storage, or by condensation after it is removed from storage.

The cartons stored at Providence stood up well in storage but were not inspected on the market. The difference in price of the cartons and crates on the market was correlated with the difference in the amount of skin breakdown of the test packages.

TABLE 3. The effect of containers on temperatures in transit.

Car No.	Average fruit temperature at loading	Position 1/ center-line	Treatment	Transit temperatures (° F.) --Days in transit--											
				0	½	1	1½	2	2½	3	3½	4	4½	5	5½
1	84.0	TD	Carton	88	82	79	74	70	64	59	58	57	55	53	52
		TD	Lined Box	81	79	78	77	73	68	62	60	57	54	52	52
		MQ	Carton	(Recording thermometer failed to operate in transit.)											
		MQ	Lined Box	80	80	79	78	75	71	67	64	61	59	57	57
2	81.7	TD	Carton	85	80	75	70	65	59	57	55	50			
		TD	Lined Box	86	86	82	77	69	60	57	52	50			
		MQ	Carton	83	82	81	79	77	74	70	68	67			
		MQ	Lined Box	85	85	84	81	74	65	61	58	56			
		BB	Carton	82	74	65	61	56	53	50	48	46			
		BB	Lined Box	83	73	63	55	49	44	42	40	38			
3	73.3	TD	Carton	72	70	67	64	61	58	57	56	56			
		MQ	do	71	71	71	69	67	64	63	62	62			
		BB	do	70	64	60	56	54	52	49	47	46			
4	78.3	TD	Lined Box	86	79	75	69	63	59	57	55	55			
		MQ	do	80	80	80	80	78	75	73	71	70			
		BB	do	81	77	66	58	52	49	47	45	44			
5	84.0	TD	Lined Box	82	81	77	73	68	66	66	61	60	60	60	
		TD	Unlined do	80	77	68	64	58	62	57	53	54	54	54	
		MQ	Lined do	80	81	82	80	77	74	73	71	70	69	68	
		MQ	Unlined do	81	78	72	67	59	59	60	56	55	53	-	

1/ TD = top doorway; MQ = middle quarterlength; BB = bottom bunker.

TABLE 4. The effect of containers on decay.

Car No.	Type of Decay	8 weeks storage at 32° F. plus:						12 weeks storage at 32° F. plus:						16 weeks storage at 32° F. plus:					
		0 days at 70° F.		3 days 1/ at 70° F.		7 days 1/ at 70° F.		0 days at 70°F.		3 days 1/ at 70° F.		7 days 1/ At 70° F.		0 days At 70° F.		3 days 1/ At 70° F.		7 days 1/ At 70° F.	
		Car 3/	Box 3/	Car	Box	Car	Box	Car	Box	Car	Box	Car	Box	Car	Box	Car	Box	Car	Box
1	Blue mold	0	0	0	0	0.8	1.0	0	0	0.2	0	0.2	0	0.2	0	0.2	0	0.8	0
	Stem end	0	0.2	0	0.6	0.4	1.0	0.2	0	0.2	0	6.1	3.0	0.6	0.4	0.6	0.4	2.5	2.3
	Other 2/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0	1.9	0.7
	Total	0	0.2	0	0.6	1.2	2.0	0.2	0	0.4	0	6.3	3.0	0.8	0.4	1.4	0.4	5.2	3.0
2	Blue mold	0	0.2	0	0.4	0.4	1.3	0	0	0.4	1.0	1.5	2.7	0.4	0.4	1.1	1.1	2.3	2.9
	Stem end	0	0.2	0	0.4	0.8	1.9	0.4	0.2	0.4	0.2	1.9	0.4	0.4	0.6	0.4	0.6	3.0	1.9
	Other 2/	0	0	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.8	0.9	0.8	0.7	2.3	2.0	7.3	7.0
	Total	0	0.4	0.4	1.2	1.6	3.8	0.8	0.6	1.2	1.6	4.2	4.0	1.6	1.7	3.8	3.7	12.6	11.8
3	Blue mold	0	-	-	-	-	-	0	-	0	-	0.7	-	0.2	-	0.4	-	1.3	-
	Stem end	0	-	-	-	-	-	0.6	-	0.6	-	1.8	-	0	-	0	-	0.2	-
	Other 2/	0	-	-	-	-	-	0	-	0	-	1.6	-	0	-	0.2	-	1.7	-
	Total	0	-	-	-	-	-	0.6	-	0.6	-	4.1	-	0.2	-	0.6	-	3.2	-
4	Blue mold	-	0	-	-	-	-	-	0	-	0	-	0.2	-	0	-	0	-	0.5
	Stem end	-	0.5	-	-	-	-	-	0.3	-	0.5	-	1.0	-	0.2	-	0.2	-	0.5
	Other 2/	-	0	-	-	-	-	-	0	-	0	-	0	-	0.1	-	0.5	-	1.7
	Total	-	0.5	-	-	-	-	-	0.3	-	0.5	-	1.2	-	0.3	-	0.7	-	2.7
								Car 5 - Bruce boxes only											
		U 4/	L 4/	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L
5	Blue mold	0	0	-	-	-	-	0	0	0.4	0.4	1.5	0.4	0	0	1.3	0	2.9	0.2
	Stem end	0	0	-	-	-	-	0	0.6	0	0.6	2.3	1.1	0.4	0.2	0.6	0.2	3.8	0.6
	Other 2/	0	0	-	-	-	-	0	0	0	0	0	0	0	0.2	0	0.4	0.9	2.4
	Total	0	0	-	-	-	-	0	0.6	0.4	1.0	3.8	1.5	0.4	0.4	1.9	0.6	7.6	3.2

[1] Decay figures at 3-day inspection includes decay discarded at withdrawal from storage. Decay figures at 7-day inspection includes decay discarded at withdrawal and 3-day inspection.

[2] Practically all "other" decay was Alternaria rot, mostly at the button.

[3] Car = half box carton; box = lined Bruce box.

[4] U = unlined; L = lined.

TABLE 5. The effect of containers on skin breakdown.

Car No.	Type of skin break-down	8 weeks storage at 32° F. plus:						12 weeks storage at 32° F. plus:						16 weeks storage at 32° F. plus:					
		0 days At 70° F.		3 days at 70° F.		7 days at 70° F.		0 days at 70° F.		3 days at 70° F.		7 days at 70° F.		0 days at 70° F.		3 days at 70° F.		7 days at 70° F.	
		Car[1] %	Box[1] %	Car %	Box %	Car %	Box %	Car %	Box %	Car %	Box %	Car %	Box %	Car %	Box %	Car %	Box %	Car %	Box %
1	Aging	0	0.4	0	0.4	2.3	1.1	3.8	3.2	11.0	4.4	13.3	10.6	3.0	5.7	6.0	9.1	15.6	16.0
	Pitting	1.5	0.8	4.2	1.3	6.8	2.7	2.7	1.1	4.2	1.0	14.4	8.4	8.0	6.5	12.5	9.9	16.4	7.4
	Total	1.5	1.2	4.2	1.7	9.1	3.8	6.5	4.4	15.2	5.4	27.7	19.0	11.0	12.2	18.5	19.0	32.0	23.4
2	Aging	3.0	0.2	4.2	2.1	6.8	2.3	4.9	1.5	6.0	3.6	6.0	4.0	6.5	7.8	10.2	7.6	9.8	8.7
	Pitting	0	0	0	0.2	0.8	0.2	3.0	1.3	4.6	1.9	12.5	5.5	12.6	9.0	26.3	15.4	17.8	14.3
	Total	3.0	0.2	4.2	2.3	7.6	2.5	7.9	2.8	10.6	5.5	18.5	9.5	19.1	16.8	36.5	23.0	27.6	23.0
3	Aging	6.5	-	-	-	-	-	6.6	-	31.1	-	28.4	-	22.7	-	25.8	-	27.9	-
	Pitting	1.5	-	-	-	-	-	4.6	-	11.4	-	12.5	-	14.8	-	20.2	-	21.2	-
	Total	8.0	-	-	-	-	-	11.2	-	42.5	-	40.9	-	37.5	-	46.0	-	49.1	-
4	Aging	-	1.0	-	-	-	-	-	0.9	-	2.7	-	2.7	-	2.9	-	4.6	-	4.8
	Pitting	-	0.5	-	-	-	-	-	0.5	-	2.5	-	2.8	-	4.0	-	6.8	-	9.4
	Total	-	1.5	-	-	-	-	-	1.4	-	5.2	-	5.2	-	6.9	-	11.4	-	14.2
								Car 5 - Bruce boxes only											
		U[2]	L[2]	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L
5	Aging	0	0	-	-	-	-	5.1	1.5	14.1	1.5	14.5	1.9	12.2	0	20.9	1.3	28.9	1.5
	Pitting	4.0	0.7	-	-	-	-	1.0	0.2	2.3	0.2	1.7	0.2	20.2	0.6	26.0	1.5	30.0	1.3
	Total	4.0	0.7	-	-	-	-	6.1	1.7	16.4	1.7	16.2	2.1	32.4	0.6	46.9	2.8	58.9	2.8

1/ Car = half-box carton; box = lined Bruce box.

2/ U = Unlined; L = lined.